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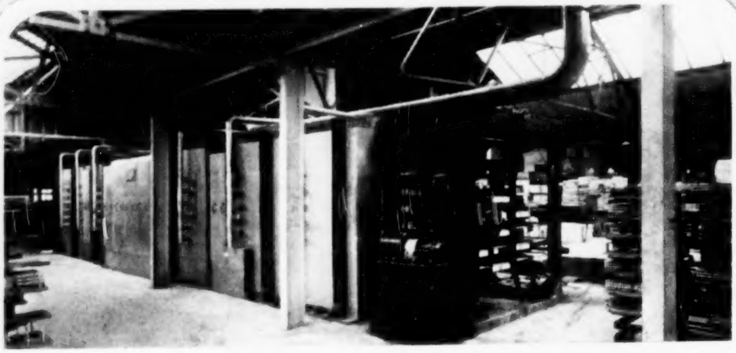

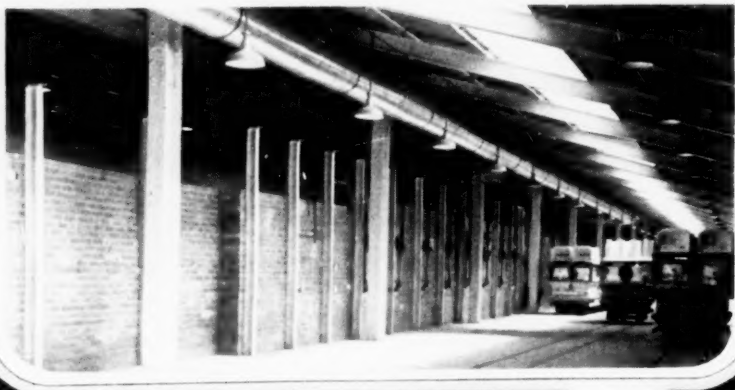

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FEATURE ARTICLES

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VOL. IV NOVEMBER, 1952 NO. 45

COMMENT

POTTERY manufacturers will have read with interest Notice to Importers No. 527, Import Licensing Branch of the Board of Trade, where among nylons, cucumbers and hot-house grapes there appears a notice for the import of pottery for the first half of 1953. It continues:

The licences will be valid (except where otherwise indicated in the Schedules) for imports originating in and consigned from any country *other than* the following:

Albania, Argentina, Bolivia, Bulgaria, Canada, Colombia, Costa Rica, Cuba, Czechoslovakia, Dominican Republic, Ecuador, El Salvador, French Somaliland, Germany (Russian Zone), Guatemala, Haiti, Honduras, Hungary, Japan, Korea, Liberia, Mexico, Nicaragua, Panama, Persia, Philippines, Poland, Rumania, Tangier, United States of America, Union of Soviet Socialist Republics, Venezuela, Yugoslavia.

The potteries look forward to the immediate results of a relaxation of the terms and conditions of sale of decorated pottery in the home market. Coronation mugs as souvenirs will see them through half of 1953.

Sufficient unto the day—but it is a planned sales programme decided upon now which finds business for the potteries when the Lord Mayor's Show ends in the middle of 1953. The quality price factor alone is the deciding factor, not only for overseas, but for home trade, and this quality price factor is interminably tied up with increased mechanisation in the production field.

NOTE FOR ABSTRACTORS.—CERAMICS, *Vol.* 4, *began on page* 1 *in March*, 1952, *and ran to page* 240 *up to and including the July*, 1952, *issue. In error the August*, 1952, *issue began again at page* 1, *and continued up to and including October*, 1952, *to page* 144.

As from November, 1952, *it will begin correctly as page* 385.

During the period August to October, 1952, *if page numbers are given in abstract references the month of issue should also be given.*

Apologies are offered for any inconvenience.

Materials Handling—A New Technology

By

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I WOULD like to stress at the beginning of this paper that materials handling does not only apply to the large works or mass production industries, but has applications just as wide in the smaller works and jobbing shops.

Now what is materials handling?

I define materials handling as the movement of everything within an establishment. The handling of the raw materials, materials between operations, stores, finished material, scrap, process machinery, the movement of workpeople in relation to the handling of material.

A shorter definition is that "materials handling is the art of rationalising the handling and movement of materials."

Mechanical Handling

When the handling of material cannot be done efficiently by hand, mechanical equipment should be put in to do the work; this is then termed "mechanical handling."

Thus it is seen that the scientific overall consideration of the movement and storage of material comes within the field of materials handling, for example, mechanical equipment may be used or handling may be obviated by the re-deployment of machines.

One of the cardinal rules of materials handling is, if possible, do not handle. The ideal factory would be conspicuous in that there would be an absolute minimum of materials handling and hence mechanical handling devices. Materials handling should not be considered by itself. There is an allied field which must be considered with materials handling, and that is "materials processing."

Materials Processing

Materials processing can be defined as the operations that material undergoes during the course of manufacture which changes its form or composition, or indicates its quality.

Examples of change of form are moulding and packaging.

Examples of change of composition are pottery firing and heat treatment.

Examples of indication of quality are inspection and moisture indication.

A little thought will show that materials handling and materials processing are closely linked, and indeed, should always be considered together. The type of processing is often determined by the method of handling and vice versa. If possible, processing should be carried out while the material is on the move. The correlation of the processing and the handling leads to uniform flow and simplifies instrumentation and control of both handling and processing. Many benefits accrue: productivity is greatly increased, process loading is much improved, inter-process stores are cut down to a minimum, bottlenecks are eliminated and the overall pulse of the organisation beats more quickly and more regularly. In practice, many other results can be claimed, such as reduction in accidents to personnel, damage to products, uniformity in products, better utilisation of labour and factory space.

It may be said that of the two, materials handling has been relatively neglected in this country. The proof of this statement lies in visits to industrial establishments when it is quite usual to see the latest type of

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A paper presented to The Pottery Manufacturers' Association on the 9th October, 1952.

machinery being fed with material lifted by hand from a pile on the floor, partly surrounding the machine. Again, articles on the platform of the latest type of motor-lorry will be loaded and unloaded bit by bit by hand.

There are two factors to be considered in the introduction of a materials handling scheme:

1. The human factor.
2. The technical factor.

The Human Factor

Human beings naturally resent both change and criticism, and these facts must be kept uppermost in mind in the introduction of any new method.

The methods of introduction depend upon whether the scheme is going into either a new or an existing plant. In the following we will consider the latter as it is one which concerns us most at the present day.

There does not appear to be anywhere near enough instruction and information given to staff and workers. The average man has had possibly over 100 years' training in political matters, but none whatsoever in economic affairs. Restricted practices in many cases are based on false premises which can only be overcome by education over a period of time, depending upon how deep are their roots. With some industries a very lengthy period of re-education would appear to be the only solution to break old practices and introduce new methods. It is necessary for a successful introduction of any scheme that full co-operation must come from the foremen and workers, and it is excellent if useful suggestions can come from them as well. For this latter to take place it is essential that they should have a knowledge of this technology and its implications.

The Technical Factor

(a) *Flow and Work Movement Charts and Three-Dimensional Models.*
It is essential to find out what is happening at the moment before any improvements can be suggested. The best way in which this can be achieved is by the use of flow and work movement charts. The establishment should be broken down into small units and each unit surveyed independently. When once a flow sheet has been made it will be found that immediate improvements can readily be seen even with an elementary knowledge of this subject.

(b) It is emphasised in (a) that only a small portion must be covered at once. Therefore the best preliminary procedure is to follow an operator, a product or a process from an arbitrary starting point to an arbitrary finishing point.

(c) The management, foremen and workers should have a knowledge of the more elementary basic principles involved, because so often valuable suggestions can come from them. No man knows his department as well as the foreman, and he, when properly guided, is in a position to do most valuable work in this field.

(d) The above personnel should have a knowledge of the equipment available, and its methods of operation.

(e) The ultimate goal, proceeding bit by bit, is from the factory of your supplier to the user of your products.

The examination of plant layout must always be with the idea of eliminating handling. If such elimination cannot be achieved by replanning of departments or machines, process integration and so on, then it is necessary to see if the handling can be done economically by machine. A basic plan should be kept in mind and, when the schemes have got under way as indicated in (e), it will cover the whole organisation not only process by process or department by department, but from works to works.

Certain sections may repay early study, e.g., loading bays, stores, plant layout and inter-departmental movement.

It cannot be too strongly emphasised that the two essential factors in any scheme are planning and organisation. Too often in factories and industrial workshops methods are being used which, like Topsy, "just growed" with no original or intermediate planning at any stage.

Application of Equipment

There are a number of simple rules for the application of materials

handling equipment and I would recommend that a study of these should take place before any schemes are considered.

One of the difficulties of planning any materials handling layout is in the correct choice of equipment. Though the range of equipment is extremely wide and in general there is more than one type which can do a particular job of work, only one will give the most efficient result. The correct choice requires knowledge and experience of the various types available. In the short time remaining for me I can only indicate some of the main types of equipment that are available, and it is important that when faced with any problem very careful consideration should be given to the choice of equipment.

Broadly, materials handling equipment can be divided into three main categories, overhead, bench and floor. There is in each category a subdivision, namely that type which will handle bulk material and that which will handle individual articles and packages.

Overhead equipment consists of overhead runways, lifting equipment, cranes and chain conveyors.

Overhead Runways

Overhead runways have many uses in industry where lifting and/or movement are required. Runway systems can be employed where the frequency of flow does not warrant a conveyor system; when the lifting and movement of material is required in situations where a conveyor or automatic device is not practicable as in feeding the machine and unloading lorries; and again where the loading of material on to a conveyor would be difficult due to bulk or weight.

A runway system can vary from a short length over a machine to a complex layout with electrically-operated turntables, switches, built-in weigh-sections and electrically-operated lifting sections. Trolleys can be of the push-travel, hand-geared or electrically-driven type. The load can be directly placed on a carrier fixed to the trolley or through the medium of lifting blocks, hand or electrically operated.

Overhead gantry cranes are too well known to need any description, the motions—longitudinal travel, cross travel and hoisting—can have manual, partly manual/partly electric, or all electric drive. I would like to draw your attention to the underhung gantry type of crane. In this design the load girder forms or is part of the crane girder, and is usually an "H" section R.S.J. on which runs a standard trolley to which is affixed the lifting blocks. Thus it is seen that the crane can be looked upon as a moveable runway. The crane girder can either be manual or electrically-driven longitudinally.

A very important feature is that the crane girder can be latched to neighbouring runways or another underhung crane either directly or by a short length of runway. This allows the trolley and blocks to be run off runways on to the crane or vice versa. Thus an extremely flexible system can be built up. The uses of this type are many, in warehousing and storage, in loading bays, and for feeding machines.

Jib Cranes

A jib crane having an "H" section bottom girder with a trolley and electric pulley blocks is extremely useful for feeding machines, and gives a much greater coverage than the single lift type.

Overhead Chain Conveyors

Overhead chain conveyors fall into two principal types. The simple overhead chain and the pre-selective discharge type.

The overhead chain conveyor is one of the most important types of handling equipment. It has normally two main functions, either as a means of transport from place to place, or to carry material through process work. Very often, however, a combination of these two functions is carried out by one conveyor, depending upon conditions. The simple form consists of a power-driven endless chain suspended from an "H" section track by means of trolleys spaced at regular intervals. Suitable carriers are hung from the trolleys to carry the load which individually may be from a few pounds to one ton in weight per carrier. Such conveyors can be made up to one mile or more in length.

(Continued on page 410.)

CASTING IN THE CERAMIC INDUSTRIES

SPECIALLY CONTRIBUTED

CASTING in plaster moulds was introduced into the ceramic industry between 1700 and 1740, apparently from France. Before this, English potters were pressing plastic bodies between moulds of metal, or of carved Staffordshire alabaster. In this way thinner articles were made than was possible by the other methods then in use.

The art of using plaster moulds was brought to this country by a Burslem potter. At that time the slip used was made from clay and water without the addition of chemical deflocculating agents. Its pint weight was in the region of 29½ oz., and it contained about 45 per cent. of water. Its disadvantages were that it did not flow readily, and was liable to trap air, giving pinholes. The high water content resulted in a high shrinkage on drying, which caused difficulty in casting intricate shapes. It also led to heavy wear on the moulds, since the large amount of water to be filtered away into the plaster dissolved the face of the mould.

Use of Chemical Deflocculents

The use of chemicals as deflocculents to increase the fluidity of slips of high pint weight was first published by C. Goetz[1] who applied for a German patent for the process in 1891. This covered the improvement in fluidity of casting slips by the addition of sodium carbonate, or bicarbonate, with or without the addition of cinnabar (mercury sulphide). The use of cinnabar is a strange one, and sodium bicarbonate is not now regarded as a deflocculent, but rather as a coagulating agent for clay slips.

Other patents followed after this date specifying, among other things, water glass, and in 1903 E. Weber[2] patented a process for casting articles from mixtures of fireclay and grog. This was similar to the process still used.

Preparation of Casting Slips

The preparation of a casting slip is a matter of treating the clay or body, usually in a plastic state, with the requisite amount of water and deflocculating agent. The deflocculent used depends on the body, and the amount added is of the order of 0.1 to 0.2 per cent. on the weight of body. For earthenware it is usual to use mixtures of sodium carbonate and silicate, and for china, sodium silicate. Other deflocculents have on occasions been used for porcelain and china, such as sodium tannate and a polymerised form of sodium phosphate. The mixing is usually done in a separate blunger, and the slip lawned into an ark, from whence it is delivered to the casters in buckets, or preferably by overhead pipes. Care should be taken in the blunging to see that the blades are covered, or air may be beaten into the slip, causing pinholes in the cast article. In some cases the slip is de-aired before reaching the casters, but the practice is not common. Properly made slip, kept moving in the pipes, does not set solid, but flushing out the pipes at regular intervals is a wise precaution.

Advantages of Alkaline Casting Slip

The advantages of an alkaline casting slip are derived from the fact that the slip can be worked at a higher pint weight without loss of fluidity. It is common practice to work at 36 oz./pt., which means that the water content is only about 25 per cent. The consequences of this are less drying shrinkage in the clayware, and less wear on the moulds, since less water has to be passed into them. There is, therefore, less solvent action on the mould face. The one disadvantage is

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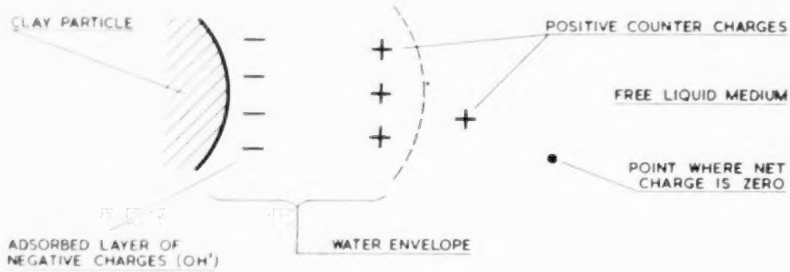

Fig. 1

that the clay particles are smaller than in the plain water slip and pack tighter on the face of the mould, with the result that the water passes more slowly into the plaster, and casting rates are slower. After use the moulds need drying before re-use, and this is done at temperatures below 130° C., since the plaster starts to decompose at that temperature.

Other Deflocculating Agents

Although in this country soda ash and soda silicate are mostly used for preparing casting slips, there are other substances which will deflocculate clay bodies, such as sodium tannate, borax, sodium oxalate, and polymerised sodium phosphate. These all have the property in common with soda ash and silicate that they are acted upon by water (hydrolysed) with the formation of negatively charged hydroxyl (OH') ions.

$$\underset{\text{soda ash}}{Na_2CO_3} + H_2O = 2Na^+ + 2OH' + \underset{\text{carbonic acid}}{H_2CO_3}$$

These other deflocculents are not used as commonly as more usual ones on the grounds of either expense or slowness of deflocculation.

Storage and Mixing of Deflocculents

The weighing of deflocculating agents and their addition to the clay is best done by some responsible person, since accuracy is essential if a consistent slip is to be prepared. The soda ash is best obtained in the anhydrous form, since the crystals tend to lose water of crystallisation when exposed to air. The product is usually of variable composition, and it is impossible without a previous analysis, to weigh out the right amount to give the required concentration of sodium carbonate. Moreover, in a damp condition it reacts with atmospheric carbon dioxide, forming sodium bicarbonate. This is undesirable, since the bicarbonate is a cause of slips thickening. Sodium silicate (water glass) is sold in the form of a syrupy liquid in which the ratio of Na_2O to SiO_2 can vary from 1:1 to 1:>4. The concentration of solid in the liquid can also vary.

Before use, therefore, one requires information on the type and concentration of silicate present. This data is supplied by reputable manufacturers, and the type of silicate used with a particular body should not be varied when working satisfactorily. The significance of the use of different silicates will be explained in what follows. Diluted sodium silicate tends to decompose when stored, and loses its deflocculating power. It should, therefore, only be diluted immediately before use.

Colloidal Properties of Clay Slips

It will now be convenient to discuss the mechanism of casting. The clay is present as particles, some of which are finer than 1μ in diameter. These exhibit colloidal properties, which means briefly that they are electrically charged and in a state of constant vibration, due to the impact on them of water molecules. The charge on the particles can be neutralised, and this causes the clay to be thrown down, or coagulated. This operation, which is the reverse of deflocculation, is called flocculation.

The charge on the clay particle can be demonstrated by passing an electric

current through a clay slip. The clay particles, which are negatively charged, move to the positive electrode, where their charges are neutralised and the clay collects. This process has been used for the purification of china clay in Germany. Another important property of some colloidal particles is the ability, under certain conditions, of taking up water and swelling.

Origin of the Charge

The origin of the charge on clay particles has been the subject of much speculation, for a resumé of which the reader is referred to a paper by A. L. Johnson and F. H. Norton,[3] since this is outside the scope of this article.

The idea advanced by these authors, and which seems most in favour at the present time, is that the negative charge on the clay particle is due to the preferential adsorption of negatively-charged hydroxyl (OH') ions. These form a layer which can be regarded as part of the solid. Surrounding these negative charges are the positive counter-charges, the whole constituting what is called an electrical double layer. The distribution of the counter-charges is such that some may be in the water layer which arises from hydration of the ions, and which is more or less bound to the clay particle, and some in the free water medium surrounding the micelle, as the particle and its associated charges is called. The depth of the water layer will vary with the degree of hydration of the positively-charged anions. At some point in the free water medium the net electric charge will be zero (Fig. 1).

When a clay is suspended in water the positive counter-charges are hydrogen ions (H^+). When substances like alkalies are added, some of these can be replaced by sodium (Na^+) ions thus:

$\text{Clay OH H} + NaOH = \text{Clay ONa} + H_2O$.

Due to hydration of the sodium ion this causes the water hull to swell, and this effect is most pronounced with monovalent ions. Similar reactions occur with soda ash and sodium silicate which give alkaline solutions by hydrolysis. E.g.,

$\underbrace{Na_2O\,xSiO_2}_{\text{soda silicate}} + H_2O = 2Na^+ + 2\,OH' + \underbrace{H_2O.\,xSiO_2}_{\text{silicic acid}}$

When base exchange is complete, further addition of alkali will increase the concentration of sodium and hydroxyl ions in the free liquid. This can result in two things:

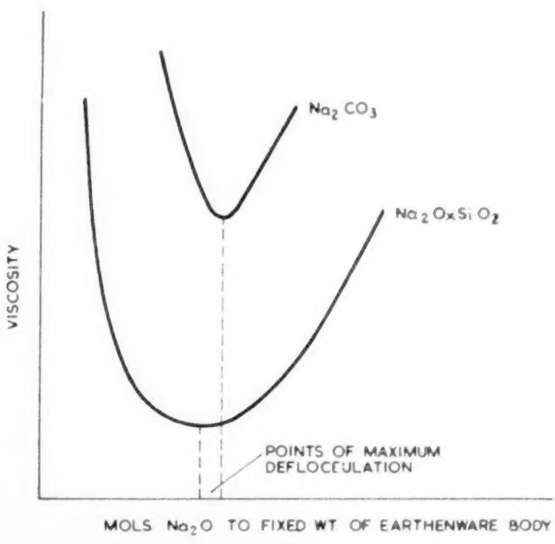

Fig. 2

(a) negatively-charged OH^- ions are forced into the micelle and adsorbed on the clay particle, thereby increasing its charge e;
(b) the dielectric constant of the free medium liquid D is reduced.

Since the potential of the particle (zeta) is given by the formula

$$\zeta = \frac{4\pi e.d.}{D}$$

where d is the thickness of the electric double layer, it follows that the effect of (a) and (b) above is to increase the zeta potential of the particle. The forces of repulsion between the particles is great, and the system is deflocculated. Monovalent ions produce the greatest effect on the particle, and the maximum degree of deflocculation. It will also be evident from the above that the presence of free OH^- ions in the liquid medium is necessary to produce the maximum effect.

As is well known, the addition of a larger excess of the deflocculent causes the slip to thicken. This is assumed to be due to the increased concentration of sodium ions in the medium forcing positively-charged sodium ions into the micelle and neutralising the effects of the negatively-charged adsorbed ions. The net charge on the micelle is thus reduced, and with it the zeta potential. The forces of repulsion between the particles are thus reduced and the slip thickens. Soluble salts such as the chlorides and sulphates of calcium and magnesium can also enter into base exchange with the clay. In these the water layer is much smaller and the equilibrium distance of the cations is reduced. The slips are therefore thicker. To allow satisfactory deflocculation it is necessary to remove these soluble salts by the addition of barium carbonate, which converts them to insoluble carbonates and sulphates.

Choice of Deflocculents

A knowledge of the colloidal behaviour of the clay in bodies helps to explain the reason why certain deflocculents are used in preference to others, and also why certain faults appear in the casting process. It is well known that colloidal systems can be stabilised, or protected against the coagulating effect of other chemicals, by the addition of certain substances which are themselves colloidal. The latter are referred to as protective colloids. Common examples are glue and some of the gums. In the ceramic field the organic carbonaceous matter in ball clays, and colloidal silicic acid produced by the hydrolysis of some of the sodium silicates are important examples. This is reflected in the ease with which black ball clays can be deflocculated to give very fluid slips.

Assessing Casting Properties

The usual way of assessing the casting properties of a clay or body is, in the first instance, to follow the change in viscosity produced when the deflocculent is added. The viscosity is then plotted against the alkali added, expressed as mols. Na_2O to a fixed weight of the plastic body or clay (Fig. 2). The point of maximum deflocculation coincides with the minimum in the viscosity curve. It will be noted that soda silicate gives the higher fluidity (lower viscosity), and this is ascribed to the fact that colloidal silica is formed and stabilises the system, which is also less affected by slight variations in that amount of alkali added at the point of maximum deflocculation. The soda ash contributes no colloidal material to the system, and gives a slip which is less fluid, and is more sensitive to errors in the amount of added alkali. Since the particles are less deflocculated, the casting time is less than with silicate.

It is in an attempt to balance the desirable characteristics of both deflocculents that, with earthenware bodies, a mixture of soda ash and silicate is usually employed. It appears, however, that the amount of protective colloid needed to stabilise a system is somewhat critical, and that if too much is added the slip becomes thick again. Thus earthenware bodies, which contain protective colloid from the carbonaceous matter in the ball clays, are best deflocculated with a mixture of soda ash and silicate of a low SiO_2:Na_2O ratio, whereas bone china, which is a body deficient in protective colloid, works best with a sodium silicate of a high silicate ratio, since then sufficient colloidal silica is added to stabilise the system.

There are certain well-known faults

38 Electric Decorating Lehr with automatic temperature control up to 600 C. (Photo by courtesy of A. & I. Friedman Ltd.)

that occur from time to time in casting. Thick, or livered, slip describes a condition in which the colloidal particles become coagulated as a result of the charges on them being neutralised. It may be only a surface effect, due to the action of atmospheric carbon dioxide, which dissolves in the water forming carbonic acid, and subsequently bicarbonate of soda, which coagulates the slip. This type of livering can often be overcome by adding a little hot water and blunging. More difficult is the general thickening of the slip. This will trap air bubbles and give pinholes in the ware made from it. Casting will be slow, and the cast will be flabby and may collapse on removal from the mould.

Such livering can result from the presence of soluble salts, which bring about coagulation of the colloidal particles. Examples are calcium sulphate from casting scraps and some kinds of hard water, soluble salts in the clays themselves, and bicarbonate of soda in soda ash which has been stored in damp conditions for some time. Another possible cause is the introduction of too much protective colloid by the use of too much, or the wrong kind, of soda silicate.

Variation in Casting Rate

This is a troublesome fault for piece workers when it lengthens the time required for casting unduly. Variations in the casting rate can arise from variations in the pint weight, or from changes in the alkali addition. A change in the kind of ball clay used may also affect the casting rate, since this is possibly affected by the presence of soluble material in the clay, and also by variations in the protective colloidal material present.

Pinholing

It has already been noted that this fault can arise from bubbles of air trapped in slip, especially when this is livered. Air bubbles can be formed in slip in a variety of ways, such as bad blunging with the paddles not covered, leaky slip pumps, and by splashing in pouring slip from jugs, etc., if these are used.

Returns from casters tend to be thicker than fresh slip, due to contact with the plaster. Such slip will tend to hold air bubbles and it should not be allowed to splash into the ark. During the casting operation water enters the mould, and the air in the pores in the plaster must escape. At times this may be through the slip in the mould. If for any reason the bubbles hold on to the side of the mould, they may cause pinholes. Sponging the mould sometimes helps in such cases.

Needless to say, the moulds must be designed to allow easy filling with the slip by the provision of suitable vents for the displaced air. Failure to do this may result in air locks, and part of the mould may not fill, or possibly the trapped air may escape by blowing a hole in the partly-cast article. This hole will probably not fill up in the subsequent casting.

Wreathing

This is a fault in which bands of unequal thickness appear on the outside or inside of the articles. On the inside it is caused by bad draining of the slip when the mould is tipped, and is caused by the slip being too thick, either as a result of livering (this can happen in the mould itself) or of the use of too much silicate. Externally the wreathing may be due to uneven porosity in the mould such as may result from uneven drying. This would cause different casting rates in different places. Lack of homogeneity in the slip may also cause it, and spinning the moulds is often done for this reason.

Solid Castings

In casting solid articles the operation is considerably prolonged, and certain possibilities of trouble exist which are not otherwise encountered in normal casting operations. Where a thick article is being made the casting becomes slower as the clay builds up on the face of the mould. Where the casting is being done from both faces of the mould it may be difficult for fresh slip to penetrate into the ever narrowing gap between the two clay layers. If this happens, and casting stops, a flabby layer may result which will crack on drying.

In order to assist the penetration of slip, and to provide a reservoir, moulds for solid casting are usually fitted with a funnel which is filled

(*Continued on page* 409.)

Depreciation and Maintenance of Pottery Manufacturing Equipment

3.—Application of "Percentage" Method

by S. HOWARD WITHEY, F.Comm.A.

FOR the purpose of reducing costs and speeding up production, the directors of a pottery manufacturing company in the Midlands recently consulted certain suppliers of mix-mullers and pulverising machinery in regard to problems of depreciation and maintenance, and by acting on the advice given, this company was able to adjust the book value of its equipment and is now in a position to incorporate a uniform figure in each year's costings.

At the end of December, 1951, the Mix-Mullers and Pulverising Machinery Account kept in the company's private ledger showed a debit balance of £15,000, and at a conference it was decided to write down the book value in such a way that at the end of seven years the account would show a balance of about £7,175. The planning department was instructed to draw up a maintenance budget covering the whole of this period, and this showed progressive increases from £300 in the first year to £1,200 in the seventh year, the actual figures being as set in Table 1.

TABLE 1
MAINTENANCE BUDGET

Year	£
1st	300
2nd	490
3rd	660
4th	820
5th	960
6th	1,085
7th	1,200

In January, 1952, additional pulverisers, ancillary plant and tools were acquired at a total cost of £6,300, including the carriage charges, installation expenses and insurance, etc., and it was desired to apply to this capital outlay a method of computing depreciation which would reduce the book value to about £3,510 in seven years' time. This meant writing off £7,825 or 52 per cent. of the old equipment, and £2,790 or 44 per cent. of the value of the new equipment, and as it was the intention to include a fixed figure in the manufacturing costs for the use of the entire equipment, it was clear that the annual rate of depreciation would have to be based on the reduced book values and not on the original capital cost. For the purpose of determining the precise rates to be applied, reference was made to a specially compiled depreciation table, of which Table 2 is an extract:

TABLE 2
DEPRECIATION TABLE FOR POTTERY MANUFACTURING EQUIPMENT

Years	7%	8%	9%	10%
1	7·00	8·00	9·00	10·00
2	13·51	15·36	17·19	19·00
3	19·56	22·13	24·64	27·10
4	25·19	28·36	31·42	34·39
5	30·43	34·09	37·59	40·95
6	35·29	39·36	43·21	46·86
7	39·84	44·21	48·32	52·17
8	44·03	48·67	52·97	56·95
9	47·97	52·78	57·20	61·26
10	51·61	56·56	61·06	65·13
11	55·00	60·04	64·57	68·63
12	58·15	63·23	67·75	71·76
13	61·08	66·17	70·65	74·58
14	63·80	68·87	73·29	77·12
15	66·33	71·37	75·70	79·41
16	68·69	73·66	77·88	81·47
17	70·88	75·77	79·87	83·32
18	72·92	77·70	81·68	84·99
19	74·81	79·48	83·33	87·84
20	76·58	81·13	84·84	87·84
21	78·22	82·62	86·20	89·05
22	79·74	84·02	87·44	90·15
23	81·16	85·30	88·57	91·44
24	82·48	86·49	89·60	92·02
25	83·71	87·56	90·53	92·83

Table 2 gives the total percentages

of the existing value which would be extinguished over periods ranging to 25 years when plant is subjected to deductions at varying rates. In the case of the original equipment, of which 52 per cent. was to be written off over seven years, the appropriate rate was 10 per cent., while in the case of the new equipment of which 44 per cent. was to be extinguished, the rate of annual deduction based on diminished book value was 8 per cent.; consequently, the depreciation computations to obtain the desired results were made in the manner shown below:

DEPRECIATION COMPUTATIONS

1st Year	£
10 per cent. of £15,000	1,500
8 per cent. of £6,300	504
Depreciation	£2,004
2nd Year	
10 per cent. of £13,500 (viz., £15,000 *less* £1,500)	1,350
8 per cent. of £5,796 (viz., £6,300 *less* £504)	465
Depreciation	£1,815
3rd Year	
10 per cent. of £12,150 (viz., £13,500 *less* £1,350)	1,215
8 per cent. of £5,331 (viz., £5,796 *less* £465)	428
Depreciation	£1,643
4th Year	
10 per cent. of £10,935 (viz., £12,150 *less* £1,215)	1,093
8 per cent. of £4,903 (viz., £5,331 *less* £428)	393
Depreciation	£1,486
5th Year	
10 per cent. of £9,842 (viz., £10,935 *less* £1,093)	984
8 per cent. of £4,510 (viz., £4,903 *less* £393)	361
Depreciation	£1,345
6th Year	
10 per cent. of £8,858 (viz., £9,842 *less* £984)	886
8 per cent. of £4,149 (viz., £4,510 *less* £361)	334
Depreciation	£1,220
7th Year	
10 per cent. of £7,972 (viz., £8,858 *less* £886)	797
8 per cent. of £3,815 (viz., £4,149 *less* £334)	305
Depreciation	£1,102

At the end of the seven years, the asset account will show the following figures:

Debit MIX-MULLERS AND PULVERISING MACHINERY A/C. *Credit*

1952	£	1952	£
Jan. To Balance brought down	15,000	Dec. By Depreciation written off	2,004
Jan. To Additions	6,300	Dec. By Balance carried down ...	19,296
	£21,300		£21,300
1953	£	1953	£
Jan. To Balance brought down	19,296	Dec. By Depreciation written off	1,815
		Dec. By Balance carried down ...	17,481
	£19,296		£19,296

1954		£	1954		£
Jan.	To Balance brought down	17,481	Dec.	By Depreciation written off	1,643
			Dec.	By Balance carried down ...	15,838
		£17,481			£17,481
1955		£	1955		£
Jan.	To Balance brought down	15,838	Dec.	By Depreciation written off	1,486
			Dec.	By Balance carried down ...	14,352
		£15,838			£15,838
1956		£	1956		£
Jan.	To Balance brought down	14,352	Dec.	By Depreciation written off	1,345
			Dec.	By Balance carried down ...	13,007
		£14,352			£14,352
1957		£	1957		£
Jan.	To Balance brought down	13,007	Dec.	By Depreciation written off	1,220
			Dec.	By Balance carried down ...	11,787
		£13,007			£13,007
1958		£	1958		£
Jan.	To Balance brought down	11,787	Dec.	By Depreciation written off	1,102
			Dec.	By Balance carried down ...	10,685
		£11,787			£11,787
1959		£			
Jan.	To Balance brought down	10,685			
		£10,685			

It should be noted that if the "straightline" method of computing and recording depreciation is applied to this set of circumstances, the total amount to be included in each year's costs would increase from £1,816 in the first year to £2,716 in the seventh year, as shown in Table 3.

By applying the "percentage" method, the total burden will be equally distributed over the period, and a fixed figure of £2,304 will be charged each year, as demonstrated in Table 4.

The general conclusion to be drawn, therefore, is that in all cases where maintenance costs are increasing each year, it is advisable to base the depreciation computations on diminishing book values in order that the annual decline in the depreciation debit will provide the margin needed to meet the expanding upkeep costs.

The next instalment of this series will discuss the problem of repairs and renewals of manufacturing equipment, indicating modern methods of accounting and classification.

TABLE 3

	Depreciation	*Maintenance*	*Total Cost*
	£	£	£
1952	1,516	300	1,816
1953	1,517	490	2,007
1954	1,516	660	2,176
1955	1,517	820	2,337
1956	1,516	960	2,476
1957	1,517	1,085	2,602
1958	1,516	1,200	2,716
TOTALS	£10,615	£5,515	£16,130

TABLE 4

	Depreciation	*Maintenance*	*Total Cost*
	£	£	£
1952	2,004	300	2,304
1953	1,815	490	2,305
1954	1,643	660	2,303
1955	1,486	820	2,306
1956	1,345	960	2,305
1957	1,220	1,085	2,305
1958	1,102	1,200	2,302
TOTALS	£10,615	£5,515	£16,130

GLASS INDUSTRIES EXHIBITION

WHAT is believed to be the first National Exhibition devoted solely to the British Glass Industry, and of interest to all users of glass in its industrial and domestic forms, will take place at the New Horticultural Hall, Westminster, London, S.W.1, on 11th-16th May, 1953.

Coming as it does just before the Coronation, the exhibition will be an opportunity for the British Glass Industry to display its resources and craftsmanship to the large numbers of home and overseas trade buyers and visitors who will be in London at that time.

In addition to the finished products of all kinds, the exhibition will include plant, machinery, raw materials, and demonstrations of glass-blowing and other processes involved in the industry.

Further information can be obtained from Mr. G. F. E. Grimaldi, at The Glass Industries Exhibition, 194-200 Bishopsgate, London, E.C.2.

Bonus for Employees. Employees who participate in the profit-sharing scheme of Quickfit and Quartz Ltd., manufacturers of scientific and industrial chemical glassware, of Stone (Staffs), a member of the Triplex group of companies, will this year receive a bonus of 8 per cent. This decision has been taken at a meeting of the company's main profit-sharing committee, presided over by Sir Graham Cunningham, chairman and managing director of the group.

Photograph by courtesy of

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4 High refractoriness to avoid warping and cracking.

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British Pottery Managers' and Officials' Association

ON the 21st October, 1952, all three branches of the above Association combined in a joint meeting in the Hanley Town Hall under the chairmanship of the president, Mr. D. Salt. The meeting took the form of short talks given by five members drawn from the various branches, and each talk was followed by a discussion.

Glazed Tiles

The first speaker was **Mr. W. Brown** of the Stoke and Hanley Branch, who briefly outlined the types of glazes used in the tile industry. He said that in the glazed tile section of the pottery industry, transparent leadless glazes are used for white and cream wall tiles, while glazes rich in lead bisilicate are used to produce the coloured bright enamel effects, both types of glaze usually being applied to tiles made from a white body.

Fireplace tiles are usually made of a buff fireclay body with many interesting types of glaze being employed, the two most important being rutile and satin or vellum glazes. Rutile break-up effects of various shades are comparatively cheap to produce and are adaptable to block-dipping by the waterfall method, which is highly effective in giving an even coating of glaze to tiles without producing dipping lines. Also as the mottled effect is entirely produced during the firing, results look more natural, no two tiles being quite alike although they blend well together when slabbed-up.

Such a glaze is produced when about 8 per cent. of pulverised rutile is added to a glaze with a high lead bisilicate content of about 85-90 per cent. Small additions of zinc oxide also help in the formation of the break-up. Vellum or satin glazes are used extensively for wall tiles in pastel shades, and due to their texture, they largely replace zinc tin and lime types of matt glaze which were in use prior to the last war. The addition of 12-15 per cent. of a mixture of zinc, tin and titanium oxides to a standard tile base glaze is a common method of producing the required effect. Combinations of rutile and satin glazes are used to produce pleasing effects. Tiles dipped in a rutile glaze and mottled with satin glaze or vice versa give a good range of effects. The mottled glaze can be applied by sponge or brush, but Mr. Brown said that two types of mottling machines are being tried out to do this mechanically. In one type the glaze pattern is applied to the tile by a series of rollers having various patterns cut in the face, while the other type employs a rotating head which allows compressed air to blow through many fine apertures on to the glaze on the tile immediately after it is passed through the waterfall of a dipping machine.

Continental Porcelain and English China

Mr. H. Strasser of the Burslem and Tunstall Branch was the second speaker. His subject was the difference between Continental porcelain and English china.

He said that porcelain was a term often loosely applied both by firms, operatives and even managers, but there is only one genuine porcelain. This consists of Kaolin, Felspar, and Silica (flint or quartz). Anything else is not genuine porcelain. The first porcelain was produced in China. In 1708, Böttger at Meissen in Germany, introduced porcelain to the western world. This was made in great secrecy, the death penalty being applied to work-people for divulging information. In the early eighteen hundred Josiah Spode perfected English bone china.

In porcelain, the fusing agent is Felspar. This has a long-firing range and is comparatively flexible. The biscuit firing is around about 1,000° C. Glost firing is high, round 1,400° C. with high shrinkage, a period of reducing firing being necessary to reduce the yellow iron oxide to whiteness. Rearing or dottling is impossible and all articles must be placed singly on the foot. The porosity is nil, whereas with bone china it may be up to 2 per cent. The firing of porcelain is done in a two-storey down-draught oven, the top section, which is the easy firing, being used for biscuit and the lower section, which is the hard firing, being used for glost.

There is some difficulty in applying lithos to porcelain. Mr. Strasser thought that it is cheaper to produce porcelain than china, one reason being that Felspar is cheaper than calcined bone, and also the production of porcelain is not so risky as that of bone china. Many attempts have been made to imitate porcelain, notably Majolica, Fayence, Delft

and soft base porcelain, but bone china always has been and will be exclusively English.

Automatic Making Machines

Mr. Hobson of the Longton and Fenton Branch gave his experience of semi-automatic making machines. He said that constant supervision and careful maintenance of these machines was essential and he thought that many such machines have been abandoned due to lack of perseverance. With a reasonably plastic body there should be less loss with semi-automatic machines than with hand jiggers, but a lot depended on the timing of the machine and on the cleanliness of the operative. A semi-automatic machine means that the pressure used in jolleying can be more accurately controlled and a bank of machines can be set to give the same pressure, with the result that more evenly nested plates are obtained than from a similar bank of hand jiggers. The scrapping method is one of the keys to success with these machines, as many faults can develop from bad scrapping, e.g., edge cracks when a worn tool is used. It is also important that moulds should be checked for proper height and a standard batch used.

Mr. G. Cartwright of the Burslem and Tunstall Branch gave a very comprehensive review of sources of loss from one end of the factory to the other, the following being some of the points he made:

Raw Materials. Clay should be stored so that none is washed away by rain and lost. A check should be made of moisture content of clays on arrival to avoid paying for excessive water. The amount of residue on lawns should be noted, and where excessive, complaints made.

Slip-house. Paint should not be spared. All beams, angle irons and supports should be kept scrupulously clean. Blungers should be periodically inspected and arks periodically thoroughly cleaned out.

Making Department. Untidy workmen use dirty moulds and are careless in their making. They should be trained to tidiness. Attention should be paid to the state of green ware before fettling, improperly dried ware causing much loss. It is as bad to throw out half-worn moulds as it is to retain moulds too old for use. Slowly-dried moulds give longer life. The extra time taken is worth money.

Greenhouse. The final overlooking of ware is of great importance, as this is the last chance before firing, and lookers-over at this stage should be extra reliable. Clay scraps can be re-used biscuit pitchers are loss.

Firing. Alumina wastage is a main form of unseen loss. Alumina is expensive and cleanliness and care are important here. In the case of tunnel ovens, emergency plans should always be displayed and all concerned should know what to do in case of emergency as the cost of a lengthy drop in temperature or other trouble can be high. Emptying of ware from ovens is another prolific cause of loss and should be constantly checked. The life of saggars should also be checked and recorded, and any drop be investigated at once.

Biscuit Warehouse. It helps if certain shapes are kept to the same people as they become used to looking for faults peculiar to these shapes. At all stages operatives should be shown the faults due to themselves and in simple language the reason and the remedy explained.

Dipping House. Each fresh batch of glaze should have full trial passed before being used. Glazes should be lawned regularly while in use.

Glost Placing. Routine checks of thimbles, strips and spurs, etc., should be made. Excessive thimble picking can be false economy and attention should always be paid to the application of bat washes which should neither be too thickly or thinly applied, both these causing trouble. Worn-out boxes or baskets are also a constant source of breakage and a form of false economy.

Intermittent Firing of China Biscuit

The last speaker was **Mr. J. Hallam** of the Longton and Fenton Branch who for his subject chose the intermittent firing of china biscuit. He pointed out that it was essential to have a good oven-man or night-man as well as a good fireman. The oven-man who was in charge for the first 24 hours of an oven can do much damage for which the fireman was frequently blamed. Baitings added at the wrong time, dampers dropped at the wrong time, ovens allowed to get back too far, followed by excessive baiting are possible faults due to oven-men. If an oven does get down too far, it is much better to add a light bait until it is burned through and then follow with a good bait afterwards. The oven-man should always report to the fireman should this happen. One of the best ways to smoke an oven is to leave it completely open, thus bringing it up gradually without forcing the heat to ascend, and giving a more solid heat throughout the whole of the setting. This gives the fireman a basis to start from and also is easier on the saggars and better for the ware, and saves time if the oven is slow in the middle. An oven taken slowly in the early stages will give straighter flat and a better colour in the body. When the fireman takes over he should immediately check all the fires to

note their state and check all spy-holes so that he knows exactly how far the firing has gone.

Just as no two firemen fire alike, so no two ovens fire alike, but the principles of firing are common to all. There should always be an adequate supply of primary air from bottom spaces between the bars and between the glut bricks and this should be drawn in all the while thus keeping the fires bright. The secondary air which passes over the fire after the baiting and the amount passing through the regulating holes is used by the fireman at his discretion to regulate the speed and method of burning. A small air space over the coal after baiting with dropped dampers as soon as the smoke has cleared, help to give heat to the tops. By observation of the flame through spy-holes the fireman adjusts the type of flame used. From 24 hours onwards trials, e.g., Bullers Rings, should be periodically drawn and the information they give, noted. It is advisable to take these trials before each baiting. As soon as the tops are up, the heat should be directed to the bottom and the middle of the oven until the required readings are obtained. Dampers must be pulled up before each baiting if they are being used, and it is always advisable that the finishing trials should be china body trials.

CASTING IN THE CERAMIC INDUSTRY.—(*Continued from page* 398.)

before the moulds are left. In designing moulds for solid casting it is important to avoid constrictions, since these are likely to cast up quickly and to prevent further slip from reaching the other parts to complete the operation.

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Positive Ventilation.—Under this title, Sturtevant Engineering Co., Southern House, Cannon Street, London, E.C.4, as publication No. 3702 superceding No. 3701, outline their contributions towards factory ventilation. The booklet is copiously illustrated with typical installations both of the static and portable type equipment.

MATERIALS HANDLING (*Continued from page 391.*)

Some designs of conveyors can rise vertically at 90° as well as travel horizontally. It will be seen that these conveyors are very flexible indeed, and between loading and unloading points can travel close to the roof or the ceiling, thus saving space which is otherwise wasted.

An elevator moves material up and down a vertical or near-vertical path. It consists of an endless belt or chain to which flights, curved arms or buckets are attached, depending upon the type of load.

Elevators are used when there is a regular or nearly regular flow of material between floors which cannot be handled satisfactorily by a lift.

Bench and floor type of equipment may be taken together for the purpose of this paper. The main types used are roller, belt and slat conveyors. Roller conveyors consist of parallel drawn steel rollers mounted in an angle-iron frame. The rollers are completely free in the gravity type and the material runs downhill under the action of gravity.

Bends are made up of tapered rollers so as to keep the loads to the centre of the conveyor. Roller conveyors may be portable, and switches, junctions and turntables are available. It has many applications in industry. An interesting use is feeding of vans and lorries at loading bays. Roller conveyors may extend into the van and can be pushed out by the loader bit by bit as the van is loaded up. Another is the feeding of a machine directly from another machine.

Belt Conveyors

A belt conveyor consists of an endless belt which may be troughed or flat with a driving unit at one end. Troughed belts are used for the handling of bulk material, flat belts for individual articles.

Many types of belts can be supplied depending upon the use of the conveyor. For example, when the belt is subjected to high temperature as in passing through an electric furnace, it may be made of wire mesh constructed from nickel-chrome wire. The maximum angle of incline for conveyors with a plain belt depends upon the material handled and varies between 15° and 25°. A new type of belt is on the market with an anti-slip surface and this can be recommended where more severe gradients are encountered.

A slat conveyor consists of a "belt" made up of a number of slats of timber, steel or aluminium, which are fastened to driving chains. The chains are driven by means of a sprocket at one end of the conveyor. It is used in similar situations to a belt conveyor, usually for heavier duties.

Portable Conveyors

There are many forms of portable conveyors, belt, slat and chain-bar being some of the more popular types. They have many applications in warehouses and factories.

Trucks

Manual trucks, as a rule, should only be used on work requiring an occasional run. There are exceptions, of course, one of these being the supply of machines in congested shops along narrow gangways.

Power trucks not only travel around an area at a greater speed than the hand truck, but can carry a greater load. What is important is that they exert a psychological effect upon the worker. For example, the driver of a power truck is generally found to keep to his job more consistently than a manual trucker.

Power-operated trucks for indoor use should be battery-electrically-operated. Apart from the advantages that the battery-electric vehicle offers, such as low maintenance cost, ease of driving, cleanliness and silence, all factors of extreme importance, it is to be noted that there can be nothing more distressing to machine operators than to be constantly engulfed in the irritating fumes of the compression ignition or petrol engine. Whether or not the fumes are injurious is at present unknown, but they are unpleasant and tend to lower the workers' efficiency.

Power trucks can be divided in two main categories: pedestrian-controlled and rider-controlled. Each of these main divisions can themselves be sub-divided into:

1. Fixed platform type, of which the terminal efficiency tends to be low.

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2. Elevating platform type, in which the load platform can be power-raised a few inches. This truck is generally used in connection with stillages and pallets, hence the terminal efficiency is high.
3. Tractors. In this case the truck does not usually carry any load. It is designed to pull a number of trailers. The terminal efficiency again is high as a tractor is used in conjunction with more than one set of trailers and the cost per ton mile is low due to the low cost and weight of the trailers.
4. Crane truck. The truck has a jib crane incorporated in it by means of which the load can be lifted on to or off the load platform.
5. High lift elevating truck. In this design the truck has a platform which will lift its load up to about 5 or 6 ft. from the floor. It is used in conjunction with stillages for delivering work to the machines and handling large pressings. The fork-lift truck is superseding it for a number of uses.
6. Fork-lift truck. One of the latest advances in the field of materials handling is in connection with the fork-lift truck and palletisation. The fork-lift combines horizontal and vertical movement. It can pick up, move and stack, and thus it economises in unskilled labour and storage space. It has to be remembered that the fork-lift truck is primarily a stacking machine and is expensive by comparison with the more simple types of power trucks. Hence fork trucks ought not to travel farther than is necessary and should not be made to replace runabout trucks.

Electronics

One of the future developments in materials handling will be in the better instrumentation and control of equipment. One of the means to achieve this is by the use of electronics.

It can be said briefly that the place of electronics in materials handling is in the accurate speed control of power drives, control of material on mechanical handling and other equipment, instrumentation and control, process mechanisation and integration.

Interesting examples are the light sensitive cell which can be used to operate some process in synchronism with articles passing on a conveyor, e.g., counting, colour sorting, for safety devices, for supplying conveyor side lines, level controls, and many other applications.

Electric space indicators are extremely useful for counting, moisture and level control. Electronic metal detectors can make a continuous check for the presence of any ferrous or non-ferrous metal in any non-metallic material.

Acoustics is a new field which is growing. Acoustics can be used for mill feed control, pre-selection on pneumatic despatch tubes, and for testing for internal flaws in pottery and china.

Automatic Regulators and Controllers

Automatic regulators and controllers have many applications. In many instances in industry some sort of correction is necessary when material is being fed into a process. This can be done by an operator continually exercising the necessary control or by mechanical or electronic methods. In the two former cases, there are the disadvantages of operator fatigue, slowness of response and inability to detect small changes. The electronic servo-mechanism overcomes these disadvantages.

An example is the control of the speed of the material through a drying oven by the moisture content of the material passing out of the oven.

Remote Instrumentation and Control

An important part which electronics can play in the field of materials handling is that of remote instrumentation, telemetering and remote control.

A simple example of remote indicating, recording and integrating is the continuous weighing of bulk material as it passes along a belt conveyor. A continuous check is kept and allowances can easily be made at an early stage if a dwindling of supplies is occurring at any place.

The British Ceramic Society, Pottery Section.—The next meeting of this Section will be on the 8th December, when a paper, "Some Theoretical and Practical Aspects of Crazing and Peeling," by Mr. L. Bullin and Mr. K. Green will be presented.

DECORATING GLASS AND POTTERY

by

L. DUBUIT

Ingenieur E.P.C.I., Licencie es Science

Machines for Decoration by the Screen Process—Flat Objects

THIS problem is identical to printing on sheets. As we saw at the beginning of this article, the impression is done by placing the sheet under the screen, and by using a squeegee the colour is forced through the holes of the mesh which have remained free. To make this easier, it is usual to have the frame on hinges, held by a solidly-made device of which several models exist. When printing on made-up objects, it is necessary to be able to place the screen at the required height, and the device is adapted for this purpose. Finally, if very large quantities are to be printed, such as in the case of glazed tiles, there are machines which can produce up to 2,500-3,000 per hour.

Articles Which Must Revolve

In this case, the article must turn around its axis. The screen moves at the same time, the squeegee being placed exactly on the point of contact between the screen and the article and thus pressing the colour through on to the article. In the case of cylindrical objects, these are placed under the screen, and turned around the axis which is parallel to the screen. The object revolves, either through being drawn by the screen with which it is in contact, or it can also be mechanically operated, this latter system being necessary when several colours are to be printed in registration.

In the case of conical articles, these will revolve around their axis, and the screen in order to follow exactly the position it must have on the article, will move around the vanishing point of the cone represented by the article.

The machines used in both of these cases are of various types, according to the production required. There are hand-operated machines to give a production of about 500 per hour. When higher productions are required, semi-automatic machines are used. In this case, the movement of the screen, the article and the squeegee are automatic, and the operator has only to feed the article to be printed on to the mandrel or rollers. Production on semi-automatics is around 1,000 per hour, and is only limited by the speed of the operator who has to put the article into its correct position. Finally, there are machines with a far greater production in which the operator loads and unloads the machine whilst it is running. These machines are of the turntable type, and give productions of 2,500-3,000 per hour.

Printing Concave Articles

This is the case with plates which have to be printed over the centre and around the rim. A special machine has been built for this purpose. The plate is placed on the machine, the screen comes down on to it and a special type of squeegee comes right over the screen, pushing the enamel through the stencil and printing the centre of the plate. To print the border, a specially shaped squeegee pivots round the axis in the

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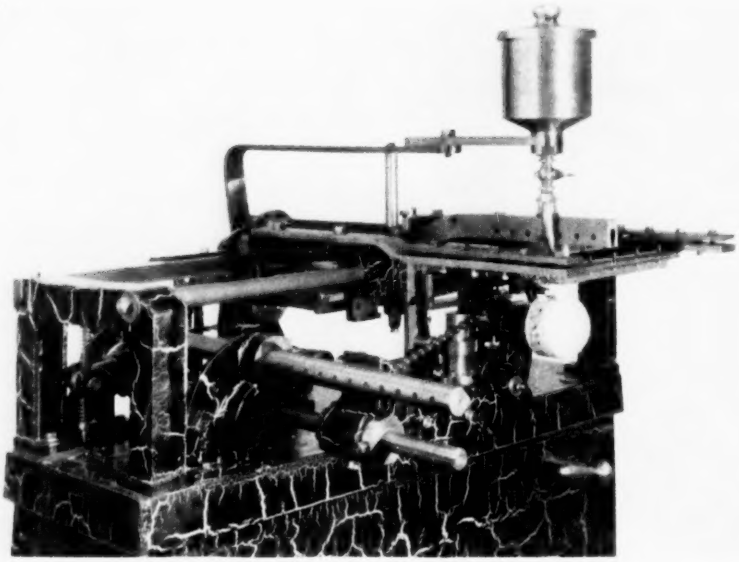
An extract from a paper presented on 17th June, 1952, to a meeting of pottery and glass manufacturers at the "Maison de la Chimie," Paris. Translated by **E. A. Kuffall** *(London agent: Dubuit Machines,* **Park Avenue**, *Twyford, London, N.W.10).*



Close-up of semi-automatic machine for printing on cups

centre of the plate, and completes the decoration.

Odd-shaped Articles

The decoration of these articles is also possible by screen. Firstly, for an article which is fairly close to a normal cylinder or cone, it is possible to print with a slack screen and if necessary by shaping the squeegee to the shape of the article. For very awkward shapes the process is to print from an ordinary screen on to paper, as in the copperplate system, and then to transfer this to the ware. This system is usually adopted when a number of articles, such as cups, saucers, and plates can be printed by machine, and only a few pieces, such as tureens, sauceboats and the like are of very awkward shapes. This method is quicker, easier, and more economical than when using engraved copper or steel plates. The result, however, is not quite so fine, as in engraving various depths and thicknesses of ink can be obtained and this is not possible by the screen method. On the other hand, it is quite possible to reproduce drawings or works of art by photographic reproduction, giving very fine results totally different to those which would have been possible by the engraving system.

Several Colours in Registration

When printing on flat objects the registration is done as in usual printing, by placing the sheet or article against adequate stops. When printing on cylinders or cones, the problem is far more difficult because articles in glass or ceramics are never perfectly identical as far as their dimensions are concerned. It would, therefore, seem to be impossible to register on this type of article. In point of fact, if there is a variation in the diameter of 3 mm., which is not unusual in pottery, the variation on the circumference will be 9 mm., and as we are revolving the article under the screen, registration with these variations would be totally impossible. However, when only a small part of the circumference is to be printed, and there is a guide as to how to place the article on the screen, this would be possible, but there would be a large proportion of misprints, and this could only be used for very short runs.

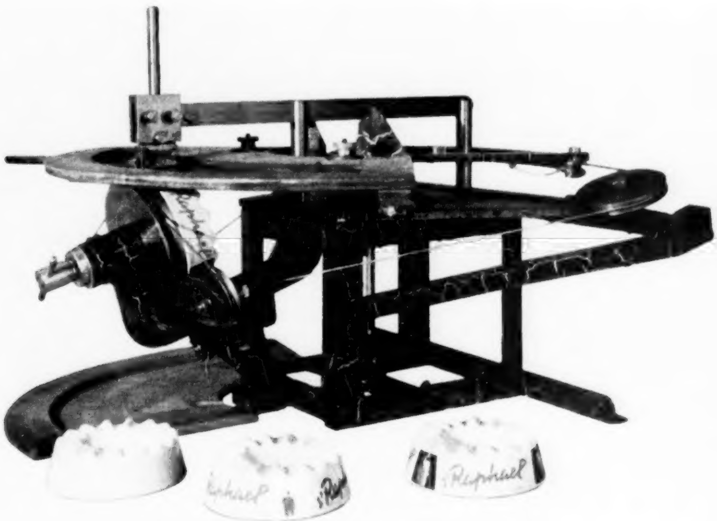
Luckily, the screen process has the peculiarity of allowing slight slips between the object and the screen without damaging the print. This is proved by the fact that quite a lot of people still print articles which are slightly conical in the same way as cylindrical objects; the print comes out quite perfect on condition that the underneath of the screen is cleaned fairly frequently.

Set for Average Article

Making use of this possibility of a slip, when printing is to be done in registration, it is sufficient to imagine an "ideal object" which represents the average of the articles to be printed. In this way, the machine will be set for the average article, and if in the course of production the articles vary slightly above or below the normal size, a slight slip will occur without causing any damage to the registration. To operate this, the article is placed in a chuck, the diameter of which will be the average diameter, and by a mechanical process, one certain point of this chuck is fixed so that it always corresponds with a certain point of the screen. The method varies according to the machine, the chuck sometimes being driven by a cable fixed to the chuck and to the screen, so that the movement of the article and the screen is identical. On certain other machines the screen and the chuck are synchronised by gears. When working on conical objects, the same principles are adopted, but the chuck is driven on a point which is the continuation of the cone of the article. Properly calculated, this will give perfect results. Finally, it is necessary to make a certain point of the article correspond with a certain point of the chuck. This is usually done by making a small mark on both the article and the chuck, these marks being placed opposite one another when printing. Certain manufacturers have found it simpler to make a mark in the mould which is always placed against the mark on the chuck. In certain cases, the object itself gives the correct position, for example, with cups, the handle can serve this purpose.

Colours for Glass

Since the screen process has made it possible to mass-produce decoration on glass, there has been a natural tendency to replace paper labels on bottles by ceramic printing, which, with firing, becomes absolutely



Printing ashtrays by hand-operated machine, with registration of colours

permanent. These ceramic labels have, of course, to stand up to much harder wear and tear than the ordinary decoration. For this reason the enamels previously used for decoration proved to be unsatisfactory when printing on bottles or jars, such as milk bottles, beer bottles, etc.

One of the principal advantages of burnt-in labels is that the container can be used a great number of times without re-labelling, but this calls for frequent cleaning in very strong caustic solutions, without mentioning that the contents of the pack are very often themselves acids, etc.

New Enamels

This has brought into being an entirely new set of enamels for which very high standards are required. In America, where a wide use is made of this type of container, the fixed standards are as follows:

The enamels must resist and remain brilliant (a) after being placed for half-an-hour in an alkali solution containing 10 per cent. of Solvay soda (sodium carbonate) and 10 per cent. of caustic soda at 80°, (b) after remaining 5 hours in an acid bath containing 5 per cent. of acetic acid at 24°, (c) resist for 1½ hours in a lactic acid bath at 48°. These standards are, of course, not very definite, and the colour manufacturers are continuing their research for even better and more resistant enamels.

Apart from these chemically-resistant standards, there are also other points to bear in mind, such as low firing temperature, expansion, and brilliancy of the colours.

These necessities have caused a lot of laboratory research. For instance, it was not possible to increase the chemical resistance simply by increasing the acidity of the enamel by adding silica, without increasing the fusing temperature, and this temperature must remain below the softening point of glass. It was therefore necessary to choose other methods, such as lead, tin, lime, soda, potash oxides, etc., in calculating the final result on the enamel under the action of caustic solutions. Finally, it has been necessary to incorporate new chemical products, such as rare earth, etc., which have given to the enamels exceptionally good chemical resistance without increasing the fusing temperature.

As the enamels used in screen decoration are very often superimposed in two, three or more colours, it is also necessary that when fusing these enamels should not mix, as the result would then be blurred. It is also necessary to prevent cracking-off, which would occur if two super-imposed enamels were too different in components, and fusability.

Using enamels without discrimination by the screen process would very often lead to poor results. This is the reason why a special range of screening enamels has been produced by the colour manufacturers. These enamels are very often supplied in powder form. Two types have been produced, one fusing between 540° and 560° C.; these are used mostly for decoration as they have poor resistance to acids and alkalis. The other range, with a higher resistance to acids and alkalis, fuse between 580° and 600° C., and are mostly used for printing on glasses, bottles, and in general on all articles which are frequently cleaned. In both types a very large range of colours is available.

Preparation of Colours

Colours in powder form are mixed with a medium which must have the following properties:

1. To burn out completely before the fusing point of the enamel without causing air bubbles.

2. Must not contain too much carbon, or leave a carbon deposit in the enamel.

3. Dry quickly enough after application to prevent the enamel from running, but not too quickly as this clogs the screens.

4. Be resistant to the drying action of the enamels.

5. Contain a sufficient proportion of evaporating agents, but not too much resin, which liquifies with heat, to prevent the colours running in course of stoving. (In general, if the firing is fairly fast, the medium contains very little resin.)

6. Contain sufficient wetting agents to enable the enamel to spread after application and thus prevent the print of the screen from being visible.

7. Be resistant to humidity.

8. Finally, not to be poisonous nor to have an unpleasant odour.

When using colours in powder form and mixing them as required, it is recommended that the powder should be heated for 24 hours at 170° C. before mixing, especially if the powder has become damp in transit. The powder is mixed with about 20 per cent. medium, and then ground.

The grinding is very important, as although simply mixing with the medium will quite well allow printing, when firing, the enamels will run and spoil the pattern completely, also the colours may be very irregular. If any foreign substance was to get mixed in when grinding, even in very small quantities, this might bring about very serious changes in the colour.

(To be continued.)

High-Frequency Ceramic Insulators

As a result of the attention today given to insulating materials required for high-frequency activities generally, no small efforts have been made to improve on existing ceramic products. Although specially selected materials are used for production, normal manufacturing processes of the ceramic industry are employed. These comprise the usual casting, turning, drawing, wet and dry pressing, etc., from which the bases of air condensers, unit coils, and bobbin holders are made.

Mechanical Strength

The best high-tension porcelain is unable to give a mechanical strength which compares with these prepared insulators, as its tensile strength ranges from 5 600 to 7 000 lb. per sq. in., whereas the latter range from 9 000 to 13 400 lb. per sq. in. Bending strength is increased from 12 700-14 000 to 20 000-23 000 lb. per sq. in., compressive strength from 70 000-78 000 to 135 000-140 000 lb. per sq. in., and impact strength from 0·12-1·0 to 1·85-2·1 ft./lb. per sq. in. The outstanding feature and which indicates the principal use, however, is the exceptionally low dielectric loss coefficient, both within the broadcasting range of 200 to 2 000 metres, and within the range of the short and ultra-short wavelengths. It is possible, for example on radio receivers, to lower the losses in the high-frequency circuits, while the selectivity can be appreciably increased. At a wavelength of 150 metres, the loss factor ranges from one-third to one-half of that of quartz ware, when making a comparison of dielectric coefficients. The superiority of these ceramics makes itself more readily marked with diminishing wavelength or rising frequency.

The loss coefficient is only one-sixth of that of quartz at a wavelength of 6 metres, and if applied to a condenser for 6 metres wavelength, this means that when using a dielectric of this order, the heating losses will only be the sixth part of those which occur with a quartz dielectric, provided the same capacitance exists with both. As can be understood, for the range of the ultra-short waves of 10 metres and under, insulating materials of this kind are specially useful.

Mass-produced Articles

With mass-produced articles such as air condensers, the base of these small objects, which formerly was made of pressed material, has been replaced by the ceramic, and by this measure the dielectric loss factor has been reduced from $5{\cdot}4 \times 10$[illegible] to the exceedingly low figure of less than 1×10[illegible] as proved by appropriate tests.

Ceramics of the kind are indifferent to heat or humidity, being perfectly dense materials and burnt at temperatures of some 1,400° C. They do not experience any change in their electrical or mechanical properties due to fatigue, and do not warp or go out of shape during service. In the instance of a triple rotary condenser or triple adjustable condenser, the main shaft is made of the ceramic, and supported in a case of the same material. This form of construction precludes any change in the relative position of the component parts, since perfect rigidity is ensured. As a result, this constancy of shape provides a corresponding constancy of capacitance or of attuning which has seldom been previously attained. This, in conjunction with the low dielectric loss, is of primary importance for the construction of unit condensers and unit coils, not to mention electrical measuring instruments of the greatest accuracy,

besides parts of high-frequency circuits.

From another aspect, a matter which is of no small importance for manufacturing reasons is that by a patent process they are enabled to permit silver-plated coatings to be immediately fused-on, and which may be of any desired shape. The winding-on of wires can be saved in the case of unit coils and many other instances. These silver-plated coatings can also be thickened mechanically or electrolytically, to the point of permitting the soldering-on of metallic parts, and in such a manner that metallic fittings can obviate all losses. This has led to a great simplification in the construction of high-frequency and radio apparatus, since fittings, terminals, and other pieces of that kind may be fastened to the ceramic by means of screws, or pipe rivets, or even by shrinking.

Ionic Valves and Special Parts

For the manufacture of ionic valves, a further patented process permits vacuum-tight joints to be made between the ceramic and glass by fusing. Where pressed materials are used for the making of intricate parts, their production does not pay because of the very expensive moulds necessary, unless they are required in very large quantities, whereas ceramic insulating bodies of the most complex shape can be economically produced, even in small quantities. This relates to pieces with high beadings, large bells, or thin ribs, such as bobbin holders. Small commercial condensers for radio and electro-medical apparatus, besides measuring instruments, were for many years made of rolled-up paper.

Today they are being ever-increasingly manufactured with a dielectric of silver-plated ceramic. This can be of a capacitance of 200 cm., but if specially severe requirements as to low dielectric losses are to be experienced, an alternative corresponding ceramic is made. For capacitances of from 200 up to 50 000 cm. condensers of the kind are fitted with a dielectric of silver-plated mica which is embedded in a flat or tubular protective case of the ceramic.

Xzit (G.B.) Ltd.—It is announced by this company from their offices at 175 Piccadilly, London, W.1, that Mr. H. F. Bromwich, who has been associated with the company for the past two years, has, for purely personal reasons, decided to take up an appointment with an associate company, namely, the Xzit Chemical Company of Hoboken, New Jersey, U.S.A. Xzit (G.B.) Ltd. wish him good fortune in his new venture.

INDIAN SPECIFICATIONS ON REFRACTORIES

by

B. L. MAJUMDER, M.Sc., A.M.Inst.F.

THE standardisation of products is an essential pre-requisite to the successful planning of the industry on sound technical grounds. Besides, this encourages the manufacturers to maintain or improve the specified quality and offers the consumers the best means of collecting useful data and correlating them under service conditions.

In the past the standards formulated by the British Standards Institution (B.S.I.) formed the basis of numerous purchase specifications of various departments of the Central and Provincial Governments. Several organisations have recently dealt with standardisation and inspection methods in their respective spheres of activity so as to meet their specific requirements. A number of laboratories have also been fully equipped for carrying out research and routine tests for various fields of science and industry. With a view to co-ordinating the multiplicity of these standards and testing methods developed by the respective organisations or laboratories and also to introducing industrial standards on the national and international plane, the Indian Standards Institution was sponsored by the Ministry of Industries and Supply, Government of India, in 1947, as the central body for issuing standards.

Refractories—High Priority

One of the principal objects of the Institution is to prepare and promote the general adoption of standards in accordance with the needs of the industry so that they may fulfil the interests of all concerned. Since its inception the programme of standardisation has been directed by immediate needs of the country and considerable progress has already been made at a pace more than commensurate with the existing state of the industry in this country. As a basic material for the development of industrial activity, the refractories received very high priority and some of the earliest standards dealt with these products. The members of the Refractories Sectional Committee E.D.C. 17 of the Engineering Division Council of the Institution, responsible for these standards on refractories, were drawn from the industry, technologists, purchasing agencies, consumers and allied interests so as to ensure full co-operation of all parties. In the course of their preparation the standards already published by overseas standards organisations, as well as those issued by the major consumers of refractories, were considered in the light of numerous data on availability of raw materials and technological practices of this country supplied by the Refractory Maker's Association and Tata Iron and Steel Co. Ltd. Before their final acceptance as national standards, they were again widely circulated, for comments, at the draft stage to all concerned interests in India and abroad.

It may be mentioned that the need for such testing and standardisation of refractory products has been felt for a very long time and several organisations drew up their purchase specifications for different grades of materials for their specific requirements. The name of Tata Iron and Steel Co. Ltd., being one of the largest consumers of refractories, stands foremost in drawing up such standards; Indian railways, Directorate of Industry and Supply, major furnace builders like Simon-Carves and other consumers, have also specified the quality of their requirements. The properties or

characteristics of the refractories covered by these specifications varied widely and the testing facilities were poor. Through Tata Iron and Steel Co. Ltd. organised elaborate arrangements for testing of refractories at their Control and Research Laboratory several years ago, it is only recently that the two national laboratories—Central Glass and Ceramic Research Institute in Calcutta and National Metallurgical Laboratory at Jamsedpur, have been equipped with modern facilities for carrying out the tests in compliance with the I.S.I. specifications. These national laboratories are also assisting the Indian Standards Institution when it becomes necessary to initiate any practical investigations connected with the standardisation of the refractories. The majority of important tests on refractories can also be carried out in the laboratories of many refractory manufacturers, Technical Colleges and Universities, and Government Test Houses.

Specifications Issued

A number of specifications on refractories for different purposes is now under the consideration of the Refractories Sectional Committee of the I.S.I. and several specifications already issued are designated as follows:

I.S.: 6-1949. Moderate Heat Duty Fireclay Refractories, Group "A."

I.S.: 7-1949. Moderate Heat Duty Fireclay Refractories, Group "B."

I.S.: 8-1949. High Heat Duty Fireclay Refractories.

I.S.: 194-1950. Recommendations for Refractories for Railways (Tentative).

I.S.: 195-1950. Fireclay Mortar for laying Fireclay Bricks.

The first three specifications

SPECIFICATIONS ON FIRECLAY REFRACTORIES

	Moderate heat duty, Group B IS: 7-1949	*Moderate heat duty, Group A IS: 6-1949*	*High heat duty IS: 8-1949*
1. Tolerances in sizes:			
on 4 in. and over	± 2 per cent.	± 2 per cent.	± 2 per cent.
on 3 in. and below (variations below [illegible] in. allowed)	± 3 per cent.	± 3 per cent.	± 3 per cent.
2. Chemical composition:			
SiO_2, not more than	75 per cent.	65 per cent.	60 per cent.
Al_2O_3, not less than	25 per cent	30 per cent.	40 per cent.
Fe_2O_3, not more than	—	—	3 per cent
CaO + MgO, not more than	—	—	2·5 per cent.
3. Pyrometric cone equivalent (softening point in Orton cone)	above 27	above 30	above 32½-33
4. Refractoriness-under-load: (a) Permanent contraction on full brick under 25 lb./sq. in. for 1¼ hours	—	less than 6 per cent. at 1,300° C.	less than 6 per cent. at 1,350° C.
5. Percentage apparent porosity (hand-moulded bricks excepted)	—	less than 25	less than 30
6. Spalling resistance, maximum loss of weight	—	15 per cent.	10 per cent.
7. Permanent linear change after re-heating (for 5 hours)	below 1½ per cent. at 1,250° C.	below 1½ per cent at 1,350° C.	below 1½ per cent. at 1,400° C.
P.C.E. (Orton cone) of fireclay mortar according to IS: 195-1950	not below cone 26	not below cone 28	not below cone 30

intended to cover the general purpose fireclay refractories are compared in the accompanying Table, and the last one deals with the corresponding classes of fireclays to be used for laying them. These fireclay mortars shall be available in three grades of fineness and their refractoriness correspond to P.C.E.'s given in the same Table. Test procedures of the A.S.T.M. have been mostly adopted for specifying these standards and it is considered that with the increasing facilities for testing, sufficient data will be collected for further modification of these standards at a later date.

The purpose of the Tentative Recommendations for Refractories for Railways is to indicate their qualities for various classes of applications in different departments and workshops of the Indian railways. Three main types of fireclay refractories have been recommended for use in different types of equipment. Though it is realised that in applications like the locomotive boiler arches, the refractories are subject (in addition to high temperature) to excessive vibrations during service, the tentative recommendations are considered to be the best till further knowledge on this subject becomes available.

Dimensions of Refractories

The desirability of preparing an Indian standard list of dimensions of refractories (on the lines of a South African standard) has also been discussed in a recent meeting of the Sectional Committee. At present only a small amount of dimensional standard shapes for lining circular, ellipsoidal and such other surfaces in each kind of refractory exists in the industry. They may be used in the construction of many furnaces with a minor alteration in the contour of their structures, without in any way materially affecting the efficiency of the installations. Many users are, however, very reluctant to entertain such a change, as an example, same classes of locomotives run by each Indian system has a different set of specifications, and consequently a small quantity of numerous shapes and sizes are required. The manufacturers meet this demand by very crude methods of their manufacture which not only slow down production but also act adversely on the quality of the product. However, it is now gratifying to note that the railways have recently worked out a scheme by which the original 190 shapes had been reduced down to fifty-six standards for the arches of old locomotives and only twenty standard bricks are required for modern locomotives.

Lower Costs

Though quality specifications form a large proportion of national standards, standards of shape and size provide for interchangeability, and when such a list is drawn out and widely accepted by the consuming industry, the demand in the industry will be fairly uniform both in regard to the shapes and qualities, and the manufacturer will be able to give greater concentration on quality control and expansion of production by mass-production methods. Application of better and efficient methods of production will inevitably mean a drop in labour costs caused by lower award rates and major saving in production affected by the standard.

Certifications Mark Scheme

The implementation of the Indian standards on refractories already drawn is gradually being accepted by voluntary measures. As these standards were prepared with full consultations of all parties, it is expected that they will be freely adopted. Though advocated by a certain section of the industry, it is not possible for I.S.I. at this stage to envisage a compulsory enforcement of the standards. The introduction of I.S.I. certifications mark scheme, designed to control the quality of production on the one hand, and assure the consumer of materials and services on the other, will provide further incentive for voluntary adoption of the standards.

Before concluding this article, the author feels that the sound specification of refractories, in addition to having to comply with standard quality and dimensions, should be based on a definite quality of performances under service conditions. If such a thing is possible, the manufacturer will be able to exercise his knowledge and ingenuity for the production of better articles than ones currently used.

New Swedish Heating Material for Ceramic Kilns

by

JOHN GRINDROD, B.A.(Com.)

BUILT up on the basis of molybdenum, a new "super-heat" type of electric resistance material for use in air has recently been developed by the Swedish firm A. B. Kanthal, of Hallstahammar, a firm which, for the past twenty years, has specialised in electric resistance materials for high-temperature furnaces.

Claimed to be able to withstand temperatures up to 1,600° or 1,700° C. (about 3,000° F.), the new alloy is expected to become of extreme importance in the design of furnaces requiring great heats when it is put on the market toward the end of the year. In developing this new powder-metallurgical product at the Kanthal laboratories the manufacturers have had in mind, in the first place, its use for firing ceramic products, and in dental furnaces and laboratory equipment. At the same time it is expected that a number of other outlets will be found for which it is suitable.

Hitherto Kanthal products in this field have been in world-wide use for temperatures up to 1,350° C. (2,460° F.) and have consisted of a series of alloys which, though largely replacing nickel, recently in short supply, have become metals in their own right. They have been used on a large scale in the ceramic, glass and metallurgical industries as well as for chemical purposes. Recent deliveries have included, for instance, the large 150-170 m. long tunnel furnaces for sanitary china at the Gustavsberg pottery works outside Stockholm. Installations for similar purposes have also been supplied to England, Chile, Argentine, Brazil, Spain, France, Germany and Kenya, to mention some of their destinations. Indeed, about 90 per cent. of the firm's production is exported. A small factory was recently opened at Stamford, Conn., U.S.A., while plans are being laid for the starting of a factory at Milan, Italy.

For these new plants the material is to be supplied from Sweden since large-scale production there permits a more homogeneous material, and Swedish iron also produces a better alloy.

With a high resistance against oxidation, sulphur resistant, homogeneous in structure, and having good welding and shaping properties and a strongly adhesive oxide layer, the chromium-aluminium-cobalt-iron alloy is made in three qualities. Kanthal A-1 has a maximum element temperature of 1,350° C., specific resistance: 1·45 q/m. and mm at 20° C., specific gravity: 7·1, increased resistance: 20°-1,350° C. = 8·5 per cent., co-efficient of elongation: 20°-1,350° C. = 0·0000278. Kanthal A has a maximum element temperature of 1,300° C., specific resistance: 1·39 q/m. and mm. at 20° C., specific gravity: 7·15, increased resistance: 20-1,300° C. = 6 per cent., co-efficient of elongation: 20-1,300° C. = 0·0000242. Kanthal D has a maximum element temperature of 1,150° C., specific resistance: 1·35 q/m. and mm. at 20° C., specific gravity: 7·25, increased resistance: 20-1,150° C. = 5·3 per cent., co-efficient of elongation: 20°-1,150° C. = 0·0000204.

The metallurgical details of the new alloy based on molybdenum will no doubt be announced in due course.

It is of interest to note that during the early days of Kanthal production, some failures in its use occurred because supporting bricks or surrounding ceramic material used in the furnaces, owing to unsuitable composition, either attacked the Kanthal elements or did not endure the higher temperatures.

In some cases they just melted down around the coil.

To counter the failures which did occur, the company's own laboratory, in collaboration with other Swedish and foreign research institutes and such industries as were interested in the new possibilities opened up by these alloys, set about finding suitable firebricks and insulating materials, ceramic embedding materials, cooking plates, etc., which at both continuous and intermittent use could resist the stresses due to the very high working temperatures produced by these elements.

A section of the "Ceramics at Home" exhibition sponsored by the *Observer* which was held at Charing Cross Underground Station from 30th September to 1st November

REFRACTORIES IN U.S. STEEL INDUSTRY

THE Anglo-American Council on Productivity report on the Iron and Steel industry in the U.S.A. was published recently.

Under the heading, "Refractories—Quality," it states:

(a) Silica

The standard American silica brick is fired to a specific gravity of 2·32 and on average contains 0·2 to 0·3 per cent. less alumina than the standard British brick. In all other aspects there is very little difference.[1] In America there are available super-duty bricks having a very low alumina content—in the West, 0·2 per cent., and in the East, about 0·3 to 0·4 per cent. These special bricks are stated to add 20 to 25 per cent. to the roof-life, but for economic reasons they are not used extensively. Low alumina-silica bricks giving very good performance have recently become available in Britain.

(b) Basic

There is little difference in the quality of basic bricks in the two countries. About 20 per cent. of the British and 70 per cent. of the American basic bricks are unfired. There is no clear evidence that any real advantage is gained from using such a high proportion of unfired basic bricks. The practice in metal-clad or in steel sheeting of basic bricks is similar in each country, but in America considerable quantities of metal-clad bricks are used for suspended construction. Square-section hydraulically-pressed magnesite bricks are available in America, whereas in Britain, until recently, magnesite bricks have usually been made in tube form, which is cheaper but more difficult to handle in wall construction.

In Britain steel furnace hearths are constructed from burnt-in magnesite, rammed tarred dolomite, or patent preparations of finely-ground dolomite. American furnace hearths are either burnt-in magnesite or rammed from a series of magnesite ramming mixes with a range of analyses (per cent.): MgO 60-80, CaO 17-4½, SiO_2 10-4½, Fe_2O_3 6, and Al_2O_3 1½-3. These ramming mixes have been developed first because burnt dolomite would hydrate during the long American transport times, and secondly because the mixes reduce the hearth installation time by about 35 per cent. Recently a new preparation of this type with high magnesia content (91 per cent.) and low lime content (1·25 per cent.) has come into service. This preparation combines the advantages of quick ramming with the durability associated with high magnesia content.

Raw dolomite is generally used for fettling, and smaller amounts of burnt dolomite or magnesite are used for the bath bottoms or bad holes.

(c) Firebricks

It is perhaps in firebricks that America has a clear advantage in quality. There are some good clays to which diaspore is added to produce bricks with higher alumina contents. The bricks are hard-fired and compared with the British equivalents have the following characteristics:

High bulk densities—2·1 to 2·4 grms. per c. cm., as against 1·8 to 2·0 gms. per c. cm. for Britain.

Low porosities—10 to 14 as against 20 per cent.

High cold crushing strengths—8,000 to 12,000 as against 7,000.

Higher underload test values.

The type of brick produced in the 35 to 40 per cent. Al_2O_3 range gives very good results in blast furnace hearths and linings, in open hearth furnace checkers and, in one or two cases, even in open hearth furnace uptakes. It is also claimed that these hard-fired low-porosity bricks are

more resistant to carbon disintegration in blast furnace linings.

(d) Carbon Bricks

Out of a total of 235 blast furnaces in America there are now eighty-six with carbon in the hearth, i.e., 37 per cent. The British percentage is about half the American. The different quality of carbon bricks in the two countries is still under detailed consideration. This British brick, made from coke and tar, may have some chemical advantages over its American equivalent made from anthracite, and also certain advantages in design.

Application

In blast furnace practice, firebricks burnt at 1,580° C., having a refractoriness of 1,760° C., are used in the bosh, the lower part of the shaft and near the throat, the remainder of the furnace being lined with firebricks burnt at 1,490° C., having a refactoriness of 1,722° C. Hearths are either carbon brick of 40 per cent. Al_2O_3 hard-fired firebrick. With the latter type of brick one furnace has produced 3,000,000 tons on one lining.

In stoves elaborately-shaped fillings are being replaced by simple shapes, and there is a tendency to use lower grade siliceous firebricks where trouble has been experienced on the top courses.

In open hearth furnaces the most popular roof construction is rings 15 in. thick with 18 in. ribs, although one roof had 9 in. rings with 12 in. ribs, and another had 18 in. rings with 21 in. ribs. In the latter the centre 12 ft. portion of the crown was 21 in. throughout. In general, American roofs are thicker than British.

Super-duty low-alumina bricks have been applied, both as complete roofs and as strips over the back and front linings. The strips are generally 6 ft. wide on the back and 3 ft. on the front. One serious drawback is the heavy breakages in handling, which are sometimes as high as 15 per cent.

Trials are being made of "zebra" roofs (mixed silica and basic brick), reports on which vary from a 20 per cent. increased roof-life to no increase in roof-life but a slightly greater rate of production.

Front and back lining practice is similar to British in the types of brick used. Generally, these are metal-cased and made of fired or unfired chrome-magnesite.

Basic ends[2] consisting of uptakes and ramp roofs are also performing a useful service and it is not uncommon for such ends to last for over 500 heats without repairs. It is claimed that when this construction is employed, the nature of the slag deposit changes and it is easier to remove. Door construction has received considerable attention, and excellent results are reported with the use of high-magnesia ramming mixes on a welded stud foundation.

The use of magnesia ramming mixes for hearths has definite advantages in reducing installation time, and the performance of the new 90 per cent. MgO, low-CaO ramming mix, with a special size grading, is a matter of considerable interest and importance. Using this material, a 200-ton furnace requiring about 100 tons of ramming took 90 hrs. from start of ramming to tapping of first charge, including 24 hrs. holding the bath at about 1,600° C. The ramming time was 13 hrs. and the setting time 5 hrs.

Excellent results are obtained in checkers using first-quality firebricks containing 35 to 40 per cent. Al_2O_3 and having low porosity. Firebricks with strong bloating tendencies are used in ladles. In the casting pit an outstanding feature is the widespread use of plumbago stoppers.

The initial treatment of refractories in new and repaired open hearth furnaces in the two countries varies considerably. In the larger American plants it is quite common to tap the first charge between 24 and 36 hrs. after the initial heating has commenced. The longest time noted was 61 hrs.; the remainder were all less than 50 hrs. Since it is the British practice not to tap until 60 to 80 hrs. after beginning the initial heat, some modifications of our heating-up technique seems to be desirable.

Performance

When comparisons are made on the only practicable basis, i.e., "unit roof-life," which takes account of variations in brick thickness, British practice gives an average figure of 150 to 170 unit roof-life and the comparable

American figure appears to be about 120 to 140. American lining lives are generally between 100 and 180 heats, and the effect of water-cooling was stated in one case to increase the lining life from 77 to 177 heats. Basic end construction, with a life of about 500 heats, has a definite advantage over the more prevalent British silica end construction. In America suspended construction for basic ends was stated to give better results than normal construction. The use of ramming mixes on a welded stud foundation for doors gives lives of 120 to 180 heats against 15 to 40 for ordinary doors, and is worthy of some attention, although the cost is about six times that of ordinary doors.

Checkers in American furnaces have exceedingly long lives—figures of 4,000 heats, or indefinitely long lives with small replacements of the top courses about every 500 heats, are quite common. This appears to be due to:

The use of firebricks of excellent quality;

The long distance between the furnace hearth and checkers, giving a large measure of protection from over-heating. Considerable extraction of waste heat and preheating of incoming air takes place in the uptakes, the very large slag pockets and the fantails;

Systematic cleaning of checkers by steam lances to maintain high efficiencies.

The larger the furnace the more pronounced these effects become.

Consumption Rates

In Table 1 the consumption of refractories per ton of steel is given for typical American and British furnaces (all fixed), together with the tonnage normally tapped.

The indications are that increasing the furnace size reduces the refractory consumption considerably in both countries, and that British consumptions are higher, as might be expected from the heavier slag rate and longer refining times.

This reduction in refractory consumption rate with size is parallel to the reduction in fuel consumption rate

TABLE 1.

EXAMPLES OF REFRACTORIES CONSUMPTION RATES (LB. PER INGOT TON)

	U.S. PRACTICE				U.K. PRACTICE			
Type of brick	200-*ton Hot metal*	200-*ton Hot metal*	180-*ton Hot metal*	100-*ton Hot metal*	70-*ton Cold-charged*	160-*ton Hot metal*	100-*ton Hot metal*	80-*ton Cold-charged*
Silica	16·5	21·2	28·0	20·6	—	—	—	—
Semi-silica	0·9	0·7	—	—	—	—	—	—
Basic	2·5	4·0	8·0	12·5	—	—	—	—
Fire-brick	5·4	6·6	3·3	6·0	—	—	—	—
Total	25·3	32·5	39·3	39·1	43	40	50	40 to 70

(7·4*b*), and it is interesting to note that both these results could be expected from geometrical considerations. The total area of the walls and roof of an open hearth furnace increases more slowly than the size in tons tapped. For example, a furnace tapping 200 tons will have a bath and roof area 1·6 times and a total wall area about 1·5 times that of a furnace tapping 100 tons. Therefore the roof and wall areas *per ton* will be less in the larger furnace by a little over 20 per cent. Refractory wear is governed to a great extent by area exposed, and therefore the consumption rate should fall with size.

Similarly, heat losses are due to conduction through the walls and to air leaks, both of which are proportional to the total area. The total losses will increase with size but less rapidly; therefore the fuel consumption rate should fall.

Conclusions

The quality of silica bricks used in America is slightly better, and the quality of firebricks considerably better, than in Britain. Basic bricks are of a similar standard in both countries. The use of basic ends on open hearth furnaces, extensive furnace cooling, and the use of archless water-cooled door frames give American practice some advantage over British. Extensive use is made of magnesite ramming mixes for hearth construction, and doors are rammed with plastic basic material.

In terms of unit roof-life British practice is better than American, but linings, basic ends and checkers give better lives on American furnaces.

The larger size of American furnaces in itself reduces the amount of refractories consumed per ton of ingots. However, even when furnaces of similar size are compared, British furnaces consume more refractories per ton of ingots on account of the higher metallurgical load, heavier slag weight and longer refining times.

In America both new and repaired furnaces are brought up to steelmaking temperature from cold much more quickly than in Britain.

REFERENCES

[1] H. M. Kraner, "Quality of Silica Brick," American Institute of Mining and Metallurgical Engineers, Open Hearth Proceedings, 1949, p. 211.

[2] American Institute of Mining and Metallurgical Engineers, Open Hearth Proceedings, Refractories and Masonry Session, 1948, 1949, 1950. All-basic Furnace Progress Reports, and Use of Basic Ends.

THE COLLAPSE METHOD OF DESIGN

UNDER the above title, Technical Brochure No. 5, issued by the British Constructional Steel Association, Artillery House, Artillery Row, Westminster, S.W.1, is available. It is largely built round the work of Professor J. F. Baker, who investigated some time ago the carrying capacity of a series of small-scale portal frames on behalf of the Institute of Welding, and who has continued his investigations since then.

It is of particular interest to the constructional steel engineer, dealing with the plastic theory and the collapse method of designing single-span beams; with continuous beams; rectangular, pinned-base portals; ridge-type, pinned-base portals; and the axial load with bending moment.

AMERICAN CERAMIC SOCIETY

TITLES of papers appearing in the American Ceramic Society *Bulletin* for October, 1952, are as follows:

"High Temperature Resistance Thermometer Temperature Controller," by W. B. Crandall and P. M. Hackett. (New York State College of Ceramics, Alfred, N.Y., and Niagara Electron Laboratories, Andover, N.Y.)

"A Method for Studying the Resistance of Enamels to Abrasion by Rapidly Moving Particles Suspended in High Temperature Flames," by Nick E. Poulos. (Georgia Institute of Technology Atlanta, Ga.)

"Applications of Thermodynamics in Ceramics. VI. Summary, Bibliography, and Sources of Data," by J. F. Wygant and W. D. Kingery. (Massachusetts Institute of Technology, Cambridge, Mass.)

"The Vibrating-Plate Viscometer An Aid in Slip-Casting Control," by J. G. Woodward. (Radio Corp. of America, R.C.A. Laboratories Div., Princeton, N.J.)

"Historical Background Development on Use of Talc in Ceramic Bodies," by W. W. Gaskins. (Sierra Talc and Clay Co., Los Angeles, Calif.)

Covering the Society's *Journal* for the same month, the titles are as follows:

"Thermal Expansion of Non-metallic Crystals," by J. B. Auston. (Research Laboratory, United States Steel Company, Kearny, New Jersey.)

"Colorimetry of Glazes," by Philip F. O'Brien. (Department of Engineering, University of California, Los Angeles, California.)

"Radiation-Absorbing Glasses," by Gordon F. Brewster and Norbert J. Kreidl. (Bausch and Lomb Optical Company, Rochester, New York.)

"Long-Time Load Tests on Commercial Classes of Fire-Clay Brick," by J. A. Crookston and D. R. Torgeson (Hays Laboratory, Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania.)

"Oxidation Products Which Contribute to the Oxidation Resistance of TiC-Base Cermets," by Harold M. Greenhouse. (Engineering Experiment Station, The Ohio State University, Columbus, Ohio.)

New German Glass Industry Headquarters

INTENDED to serve as a demonstration of the many possibilities of glass in building work and, also, functionally, as the administrative centre of the German glass industry, a new headquarters has recently been erected in Düsseldorf.

Designed by architect Bernhard Pfau, this extremely modern and attractive building took over seven months to plan and sixteen months to construct, and it is particularly interesting in that glass has been used for every purpose within the realms of possibility, yet without exaggerating its use.

The building itself is borne on interior steel pillars and gable walls so that façades and interior partitions could be of the curtain type, lending themselves to the use of lightweight materials and giving greater lightness inside.

Opening into a small reception room, whose wall reflecting mirrors give a spacious effect, is a topaz-coloured plate-glass entrance door. In the halls, both on the ground floor and on the three upper storeys, as well as in the outside wall of the staircase, glass-bricks have been used. The ceiling of the staircase also carries circular glass-bricks embedded in concrete.

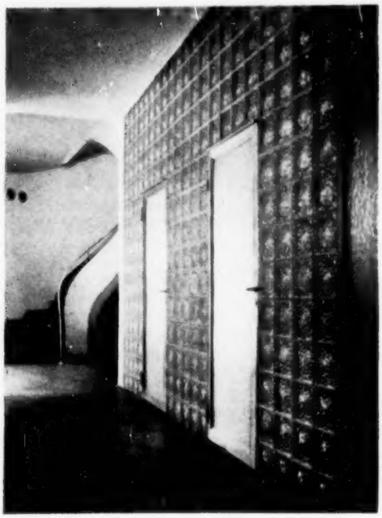
Besides the office accommodation on the ground floor there is a special room for exhibiting the products of the West German glass industry. The exquisite light effect in this room is caused by a combination of concrete glass-brick ceiling, an outside wall of patterned wire glass and the light green sheets of opaque glass used in the other walls.

The partitioning walls of the three office storeys are of painted patterned wire glass and polished plate-glass in a very small profiled iron-wood frame. Between the floors mats of glass wool are used for sound insulating purposes.

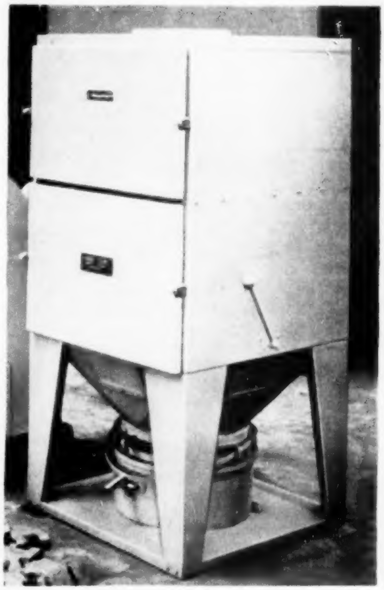
Two conference rooms and a refreshment room are on the top floor of all. Here again the decoration is

A view of the Conference Room

quite unique and is provided by dark brown mirror glass on the walls, light topaz-coloured window sheets, almond green curtains and a fine grey carpet. In the refreshment room, beige-coloured opaque glass sheets cover the walls and floor. The street side of the refreshment room is a whole glass front, double lined, and between the two plates exotic flowers are growing. There is also a large sliding glass door leading to a terrace.



A view of the entrance hall



Dallow, Lambert and Co. Ltd., of Leicester, announce a new type of unit dust collector, which is at present available in the 100 Series, and will shortly be offered in two other series, 50 and 150, making a total of 135 different combinations from which requirements may be selected. Fixed fan, filter and storage capacities have, in the past, limited application of large units. The new unit under the trade name "Dustmaster" is claimed to overcome this limitation

ADVERTISERS' INDEX

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